remote sensing

Supplementary materials

This document contains selected indicators from household survey (HH data) followed by the sampling method for the quick scan (QS) survey and its indicators.

S1. HH data

Table S1 shows the HH indicators, respective categories and references and their relations with deprivation dimensions.

Table S1. Household survey (HH data). Selected indicators with their categories and references and relations with deprivation dimensions.

Deprivation Dimension	Indicator form HH survey 2010	Categories	Assumption	Reference
Social Capital	Caste	1. Scheduled caste 2. Scheduled tribe 3. Backward class 4. Other backward class 5. General caste	Belonging to scheduled caste causes systematic differences in access to education and health services	[1]
Human Capital	Highest educational obtained	1. non-formal schooling 2. some formal schooling 3. Primary school 4. Middle school 5. High school 6. Pre-university college (puc) 7. Technical training 8. Bachelor's degree 9. Post-graduation 10. No education	Higher educational level reflects accessing to higher-skilled occupation and better livelihood	[2]
	Dependency rate	Proportion of workers in relation to all HH members (a continuous number between 0 and 1)	Having more workers enables more possibility to have better livelihood	[3]
	Distance to healthcare	1. Less than 1km 2. 1 to 5km 3. more than 5km	More accessible healthcare facility potentially provides better healthcare services to HHs and decreases deprivation	[3]
Financial Capital	Income (Rupee/month)	1. [200, 1300) 2. [1300, 2400) 3. [2400, 3500) 4. [3500, 4600) 5. [4600, 5700) 6. [5700, 8000) 7. [8000, 12000) 8. [12000, 18000) 9. More than 18000	More income results in less poverty and deprivation	[4]
	Ration card	1. Anthyodaya 2. BPL 3. APL 4. No ration card	More deprived areas have more ration cards. Anthyodaya was assumed as the ration	[2] (Expert consultation)

Deprivation Dimension	Indicator form HH survey 2010	Categories	Assumption	Reference
			card for worse-off people	
Physical Capital	Water source quality (Provided for summer and other seasons separately)	1. Individual water connection 2. Makeshift water connection 3. Individual sub-connection 4. Mini water supply 5. Public tap 6. Community well / hand pump 7. Water tanker 8. Surface water 9. Other vendors	More private and in-building water sources have better quality	[2]
	Toilet facility	1. No toilet 2. Toilet shared with neighbors 3. Community toilet – free 4. Open space 5. Community toilet – paid 6. Other toilets 7. Own toilet	More private sanitation types have better quality and are more hygienic	[2]
	Access to Electricity	1. Metered connection 2. Unmetered connection 3. Unofficial or makeshift connection 4. Through sub-contractor 5. No electricity	More official connection leads to better quality of electricity and less deprivation	(Expert knowledge)
	Crowdedness (pop/m^2)	Living area per capita	More living space shows less slum-ness and less deprivation	[3]
	Dwelling age	Continuous variable of dwelling ages by year	Better-off slum dwellers live in older dwellings	[5]
	Floor material	1. Mud 2. Wood/Bamboo 3. Brick 4. Stone 5. Cement 6. Mosaic/Tiles 7. Other floor materials		[2]
	Wall material	1. Grass/Thatch/Bamboo 2. Plastic/Polythene 3. Mud/Unburnt 4. Brick 5. Wood 6. G.I./Metal/Asbestos 7. Burnt brick 8. Stone 9. Concrete 10. Other wall materials		[2]
	Roof material	1. Grass/Thatch/Bamboo/Wood /Mud 2. Plastic/Polythene 3. Tiles 4. Slate		[2]

Deprivation Dimension	Indicator form HH survey 2010	Categories	Assumption	Reference
		5. G.I./Metal/Asbestos 6. Brick 7. Stone 8. Concrete 9. Other roof materials		
Contextual capital	Travel time to services (Education/Work/ Household purposes)	Average minutes take to get to education/work/household purpose in a household		[6]

S2. QS data

Section S2.1 describes the sampling method we use to select the QS samples and section S2.2 shows the QS data in detail.

S2.1. Sampling method

As the time for fieldwork is limited, a two-stage cluster sampling instead of simple random sampling is selected [7]. We target collecting data from 100+ samples but a simple random sampling cannot achieve this as there are lots of difficulties in transportation in Bangalore and many gridlocks. Therefore, a two-stage cluster sampling is designed as follows:

Since we have 15 days to collect data, we needed 15 clusters and on average 7 samples in each to reach about 105 samples (this is then summed up with 37 HH samples). As the maximum distance of two neighboring slum settlements is 2.1km, the study area is split into 4km by 4km grids, so each grid contains at least 7 samples theoretically[1]. Samples within the clusters located at the city center are few, but within the clusters located at the periphery are abundant. To increase efficiency, clusters at the periphery with less than 7 samples are removed, but all clusters located in the city center remain to avoid losing representativeness of samples.

After selecting clusters as explained in the previous paragraph, we need to select some samples among samples within those clusters. There are two ways of selecting samples, but each has specific disadvantages: 1) By selecting samples systematically, we minimize the effect of spatial autocorrelation, but we also minimize the representativeness of the selected samples. 2) With random sampling, we select more representative samples, but we keep the effect of spatial autocorrelation. To deal with this problem, [8] presented a two-stage cluster sampling; first choosing clusters systematically (i.e., dispersed), then choosing random samples within the clusters. The same approach was conducted, a set of spatially dispersed points is created, and 15 clusters are chosen based on points' location, so 375 samples are selected out of 1461 slums. Using Google Earth, samples within the chosen clusters are verified, and the ones which have no settlement anymore are removed. Out of 375 samples, 208 samples remain. From the 208 samples, 107 samples are randomly selected proportionally based on the number of samples within each cluster. After adding 37 samples, for which we have detailed data (HH data), to the 107 samples (144 samples is the total), all samples are coded, then an online Google map and an offline locus map containing samples, as well as an SPSS template, are prepared and are introduced to the surveyor.

After completion of the survey, data of all 144 samples are checked with the Pleiades images to be prepared for further analysis. After clearing samples, 121 samples remain. Reasons for removing some samples are as follows: Some samples are very remote or are not accessible due to safety reasons, so data about them are missing. As mentioned earlier, samples that we have detailed household survey data about are also supposed to be surveyed again during the fieldwork. However, some of them have significantly changed or seem to have changed to formal residential areas, so such samples are also removed to avoid confusion (see Figure S1 as an example).

[1] In a 4km by 4km grid, we can theoretically cover 9 samples with >=2km distance from each other. Here, by distance, we mean distance of two centre points.

Figure S1. An example of a slum in 2010 (left) which was re-developed in 2017 (right). Source: Google Earth.

S2.2. QS indicators

The indicators covered three categories, i.e., building, environment, and people. These indicators are selected based on the literature as well as experts' opinions to explain deprivation in slum areas (Tables S2 to S7).

The idea is to briefly scan each slum area (identified by their boundaries) visually and check the most relevant choices in the indicator list. The slum areas are defined by the boundaries (i.e., polygons). Use Locus map or online google map to find them with their respective unique ID. The idea is to find each area and look for a typical location somewhere close to the entrance to assess.

To make the indicators easy to collect, they are designed to be binary or categorized in levels, as many of them are subjective or qualitative indicators. The levels are mostly relative and can have different meanings in the context.

Table S2. Quick scan (QS) building-related indicators with respective references.

Indicator	*Reference*
Dominant building type	[9,10]
Number of floors	[9]
Dominant building footprint size	[9,11,12]
Wall material	[9,11,12]
Roof material	[9,11,12]
Dominant shape of buildings	[9,12]
Overall state of the buildings	(Expert knowledge)
Overall building appearance	(Expert knowledge)
Open spaces/green spaces*	[11–13]
Appearance of open space	(Expert knowledge)

Table S3. QS environment-related indicators with respective references.

Indicator	*Reference*
Presence of roads	[9]
Road pavement (if there is road)	[9,11]
Road material	[9,11]
Road width (if there is road)	[9]

Cables for electricity	[11]
Presence of footpaths	[11]
Footpath material (if there is footpath)	[11]
Street light	[11]
Pollution (smell)	[10–12,14]
Pollution (mechanical or extraordinary traffic noise)	[10–12,14]
Pollution (waste)	[10–12,14]
Open sewers	[11]
Presence of public toilet	(Expert knowledge)
Waterbody	(Expert knowledge)
Economic activities	[15]
Type of economic activities (if there is any)	[15]
Dominant land use next to the neighborhood	[12,13]
Feeling safe	[12]
Are people interacting or chatting?	[14]
Are there vehicles visible within the area?	[10]
Is there any temple?	(Expert knowledge)

Table S4. QS people-related indicators with respective references.

Indicator	*Reference*
Clothes of people	[10]
Having jewelry	[10]
Hair of children	(Expert knowledge)
Children toys	[10]

Table S5. QS building-related indicators with categories used during the survey.

Indicator	*Level*				
Dominant building type	○ Single-story	○ Single-story with garden	○ Multi-story	○ Multi-story with balcony	
In case of a mix of building types specify the approximate %	_____%	_____%	_____%	_____%	
Number of floors	○ One	○ Two	○ Three	○ Four	○ Five +
In case of a mix of number of floors specify the approximate %	_____%	_____%	_____%	_____%	_____%
Dominant building footprint size	○ Very small	○ Small	○ Medium	○ Large	○ Very large
Wall material	○ Temporary	○ Permanent	○ Mix		
Roof material	○ Plastic	○ Metal	○ Asbestos	○ Tile	○ Concrete ○ Others please specify: ____
In case of a mix of roof material specify the approximate %	_____%	_____%	_____%	_____%	_____% _____%
Dominant shape of buildings	○ Simple	○ Complex			
Overall state of the buildings	○ Not maintained well	○ Well-maintained			
Overall building appearance	○ Simple	○ Some decorations	○ Many decorations		
Open spaces/green spaces	○ Not available	○ Some	○ Many		
Appearance of open space	○ Clean without vegetation	○ Clean with vegetation cover	○ Not clean without vegetation cover	○ Not clean with vegetation cover	

Table S6. QS environment-related indicators with categories used during the survey.

Indicator	*Level*
Presence of roads	○ No ○ Yes
Road pavement (if there is road)	○ Not paved ○ Mostly unpaved ○ Mostly paved ○ All paved
Road material	○ Asphalt ○ Gravel ○ Sand ○ Cobble ○ Mix ○ Other, please specify:
Road width (if there is road) (meter)	○ [1-1.5] ○ (1.5-2.5] ○ (2.5-4] ○ (4-6] ○ More, please specify:
Cables for electricity	○ Not exist ○ Exist
Presence of footpaths	○ Not exist ○ Exist
Footpath material (if there is footpath)	○ Asphalt ○ Gravel ○ Sand ○ Cobble ○ Mix ○ Other, please specify:
Street light	○ Not exist ○ Exist
Pollution (smell)	○ Yes ○ No
Pollution (mechanical or extraordinary traffic noise)	○ Yes ○ No
Pollution (waste)	○ Yes ○ No
Open sewers	○ Yes ○ No
Presence of public toilet	○ Yes ○ No
Waterbody	○ No waterbody ○ Polluted waterbody ○ Clean waterbody
Economic activities	○ Yes ○ No
Type of economic activities (if there is any)	○ Agriculture ○ Small commercial ○ Animal husbandry ○ Manufacturing
Dominant land use next to the neighborhood	○ Industrial ○ Agricultural ○ Residential ○ Commercial
Feeling safe	○ Not safe ○ Relatively safe
Are people interacting or chatting?	○ No ○ Yes

Indicator	*Level*				
Are there vehicles visible within the area?	○ Nothing	○ Bikes	○ Motorbikes (or scooters and Rickshaws)	○ Cars	○ Trucks
Is there any temple?	○ No	○ Yes, Hindu	○ Yes, mosque	○ Yes, other	

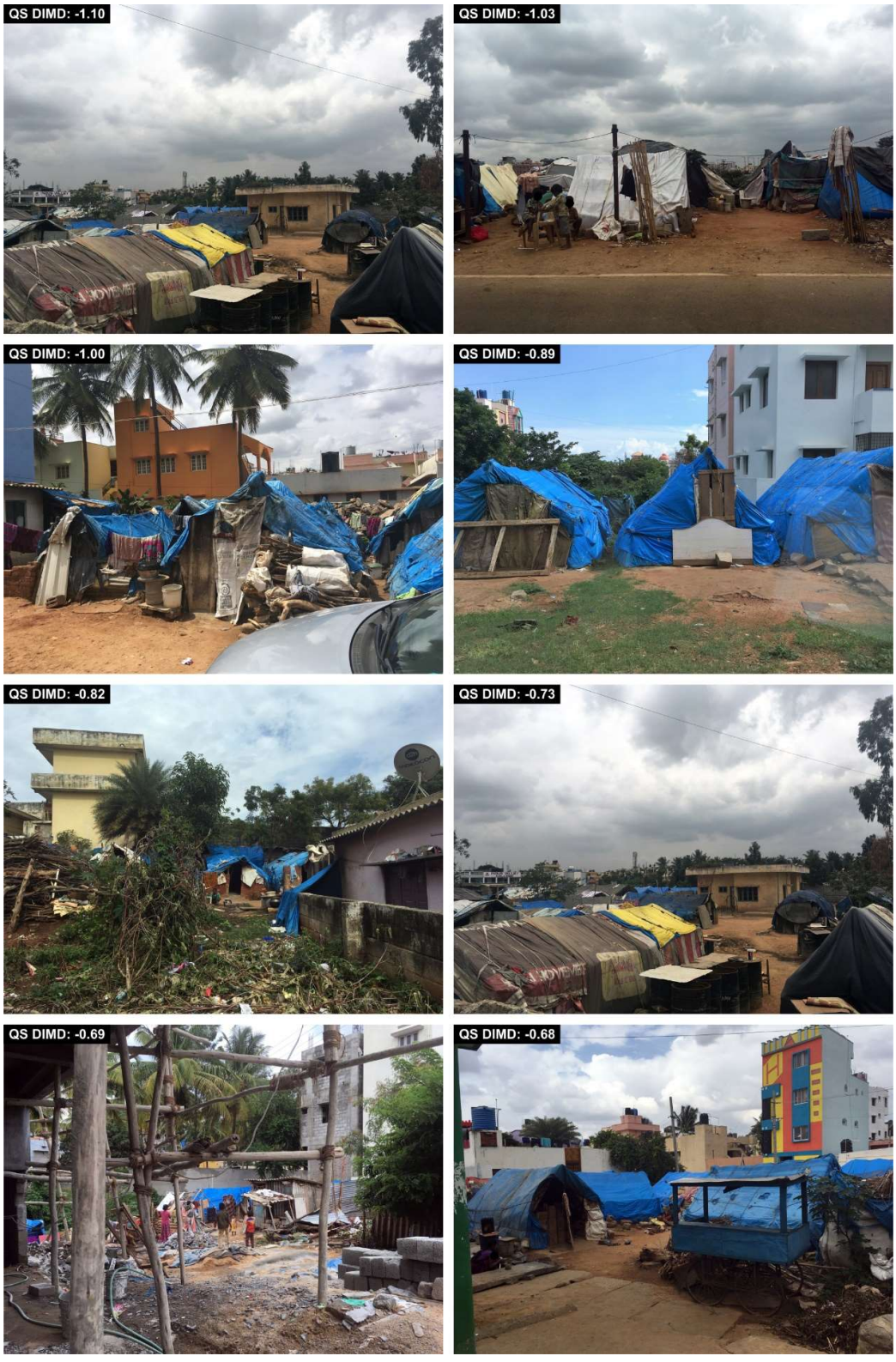
Table S7. QS people-related indicators with categories used during the survey.

Indicator	*Level*		
Clothes of people	○ Torn and shabby	○ Basic	○ Well-dressed
Having jewelry	○ Almost no	○ Some	○ Many
Hair of children	○ Not maintained well	○ Maintained	
Children toys	○ No toy	○ Basic toys	○ Good toys

To prepare the collected fieldwork data for the analysis, three indicators, dominant building type, number of floors, and roof material, that we have each category in percentage are aggregated, and the dominant category is considered for each slum. Other indicators remain unchanged as they are already prepared with multiple choice possibilities.

S3. Ground photos from QS samples

The section provides pictures from QS samples with DIMD QS values from worst to better-off slums. The photos were taken during the QS survey.




QS DIMD: -0.65
QS DIMD: -0.62
QS DIMD: -0.57
QS DIMD: -0.56
QS DIMD: -0.54
QS DIMD: -0.48
QS DIMD: -0.44
QS DIMD: -0.41

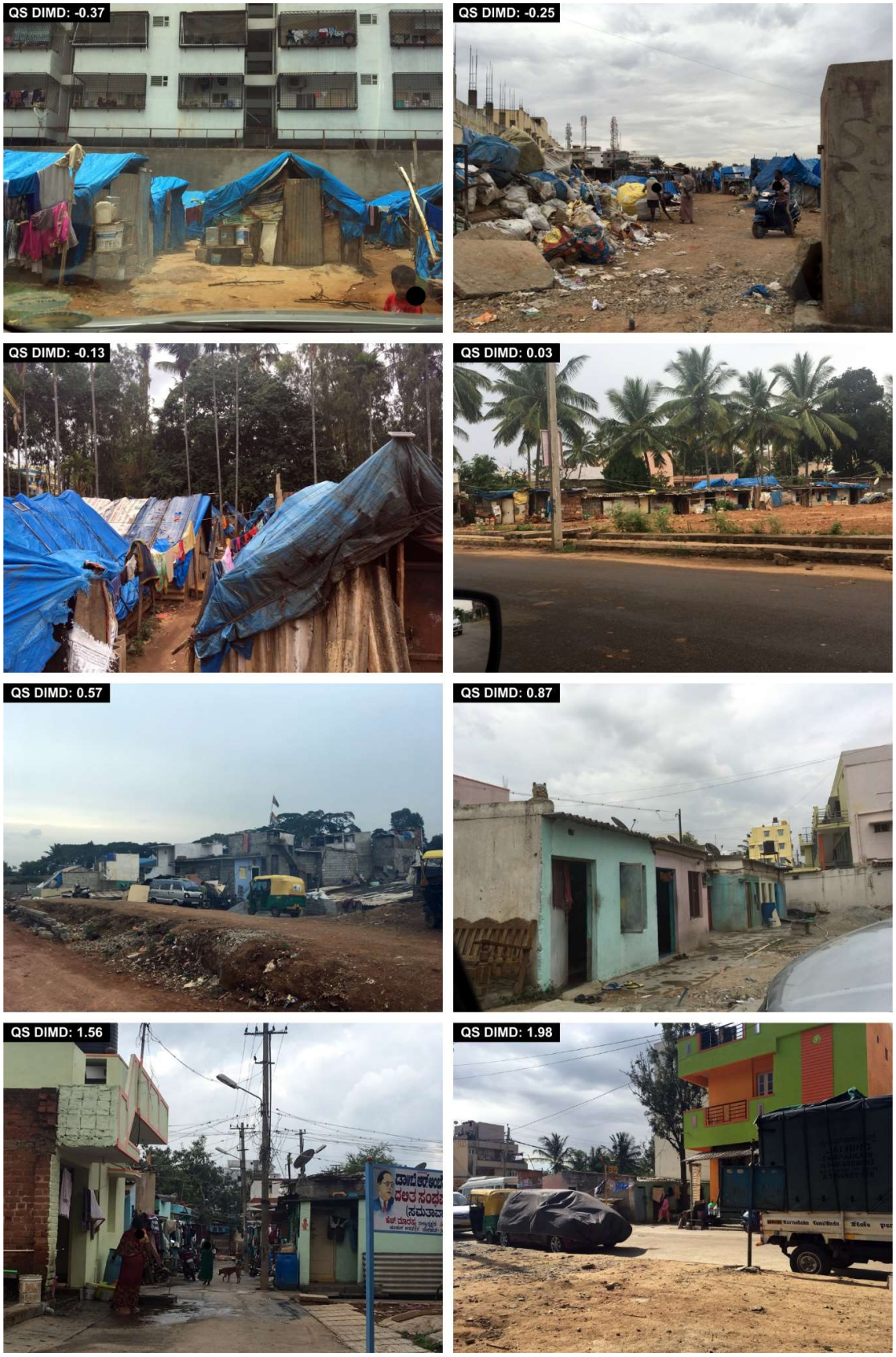

QS DIMD: -0.37
QS DIMD: -0.25
QS DIMD: -0.13
QS DIMD: 0.03
QS DIMD: 0.57
QS DIMD: 0.87
QS DIMD: 1.56
QS DIMD: 1.98

Figure S1. Ground photos from the QS slums with respective QS DIMD. Source of the photos: Chloe Pottinger Glass, 2017.

It is important to consider that not all of the QS indicators are visible in a single image of a settlement.

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